

-- *WILLETT POND DAM* --
PHASE I
INSPECTION / EVALUATION REPORT



Dam Name: Willett Pond Dam

NID ID#: MA00169

Owner: Neponset River Land Holding Association

Town: Norwood/Walpole, MA

Consultant: Fuss & O'Neill, Inc.

Date of Inspection: June 6, 2017



EXECUTIVE SUMMARY

This Phase I Inspection/Evaluation Report details the inspection and evaluation of Willett Pond Dam and Dike in Norwood/Walpole, Massachusetts. The inspection was performed on June 6, 2017 by Fuss & O'Neill, Inc. Fuss & O'Neill recommends the following actions be taken to address the deficiencies observed or found.

Willett Pond Dam is classified as a **Large, High Hazard Potential (Class I)** dam. The dam was found to be in **Poor** condition with the following deficiencies:

- Spillway Capacity capable of passing approximately 13 percent of the Spillway Design Flood (SDF) without overtopping
- Minor dike crest height irregularity
- Sparsely vegetated areas on the dike

The specific reason for the Poor rating is the inadequate spillway size in accordance with 302 CMR 10.14. If the spillway were adequately sized, this dam would be classified to be at least fair.

Fuss & O'Neill recommends the following actions be taken to address the deficiencies observed or found at the dam during this inspection and evaluation:

1. Develop a spillway design capable of safely passing the SDF
2. Remove woody vegetation from dike
3. Seed sparsely vegetated areas on the dike

Dam Evaluation Summary Detail Sheet

1. NID ID:	MA00169	4. Inspection Date:	June 6, 2017
2. Dam Name:	Willett Pond Dam and Dike	5. Last Insp. Date:	July 7, 2015
3. Dam Location:	Norwood, MA	6. Next Inspection:	June 6, 2019
7. Inspector:	Shawn King		
8. Consultant:	Fuss & O'Neill, Inc.		
9. Hazard Code:	High	9a. Is Hazard Code Change Requested?:	No
10. Insp. Frequency:	2 Years	11. Overall Physical Condition of Dam:	POOR
12. Spillway Capacity (% SDF)	0-50% of the SDF or Unknown		
E1. Design Methodology:	3	E7. Low-Level Discharge Capacity:	4
E2. Level of Maintenance:	4	E8. Low-Level Outlet Physical Condition:	5
E3. Emergency Action Plan:	5	E9. Spillway Design Flood Capacity:	1
E4. Embankment Seepage:	5	E10. Overall Physical Condition of the Dam:	2
E5. Embankment Condition:	4	E11. Estimated Repair Cost:	\$1,046,900 - \$4,910,000
E6. Concrete Condition:	4		

Evaluation Description

E1: DESIGN METHODOLOGY

1. Unknown Design – no design records available
2. No design or post-design analyses
3. No analyses, but dam features appear suitable
4. Design or post design analysis show dam meets most criteria
5. State of the art design – design records available & dam meets all criteria

E2: LEVEL OF MAINTENANCE

1. Dam in disrepair, no evidence of maintenance, no O&M manual
2. Dam in poor level of upkeep, very little maintenance, no O&M manual
3. Dam in fair level of upkeep, some maintenance and standard procedures
4. Adequate level of maintenance and standard procedures
5. Dam well maintained, detailed maintenance plan that is executed

E3: EMERGENCY ACTION PLAN

1. No plan or idea of what to do in the event of an emergency
2. Some idea but no written plan
3. No formal plan but well thought out
4. Available written plan that needs updating
5. Detailed, updated written plan available and filed with MADCR, annual training

E4: SEEPAGE (Embankments, Foundations, & Abutments)

1. Severe piping and/or seepage with no monitoring
2. Evidence of monitored piping and seepage
3. No piping but uncontrolled seepage
4. Minor seepage or high volumes of seepage with filtered collection
5. No seepage or minor seepage with filtered collection

E5: EMBANKMENT CONDITION (See Note 1)

1. Severe erosion and/or large trees
2. Significant erosion or significant woody vegetation
3. Brush and exposed embankment soils, or moderate erosion
4. Unmaintained grass, rodent activity and maintainable erosion
5. Well maintained healthy uniform grass cover

E6: CONCRETE CONDITION (See Note 2)

1. Major cracks, misalignment, discontinuities causing leaks, seepage or stability concerns
2. Cracks with misalignment inclusive of transverse cracks with no misalignment but with potential for significant structural degradation
3. Significant longitudinal cracking and minor transverse cracking
4. Spalling and minor surface cracking
5. No apparent deficiencies

E7: LOW-LEVEL OUTLET DISCHARGE CAPACITY

1. No low level outlet, no provisions (e.g. pumps, siphons) for emptying pond
2. No operable outlet, plans for emptying pond, but no equipment
3. Outlet with insufficient drawdown capacity, pumping equipment available
4. Operable gate with sufficient drawdown capacity
5. Operable gate with capacity greater than necessary

E8: LOW-LEVEL OUTLET PHYSICAL CONDITION

1. Outlet inoperative needs replacement, non-existent or inaccessible
2. Outlet inoperative needs repair
3. Outlet operable but needs repair
4. Outlet operable but needs maintenance
5. Outlet and operator operable and well maintained

E9: SPILLWAY DESIGN FLOOD CAPACITY

1. 0 - 50% of the SDF or unknown
2. 50-90% of the SDF
3. 90 - 100% of the SDF
4. >100% of the SDF with actions required by caretaker (e.g. open outlet)
5. >100% of the SDF with no actions required by caretaker

E10: OVERALL PHYSICAL CONDITION OF DAM

1. UNSAFE – Major structural, operational, and maintenance deficiencies exist under normal operating conditions
2. POOR - Significant structural, operation and maintenance deficiencies are clearly recognized under normal loading conditions
3. FAIR - Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters
4. SATISFACTORY - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result in deficiencies.
5. GOOD - No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF

E11: ESTIMATED REPAIR COST

Estimation of the total cost to address all identified structural, operational, maintenance deficiencies. Cost shall be developed utilizing standard estimating guides and procedures

Changes/Deviations to Database Information since Last Inspection



PREFACE

The assessment of the general condition of the dam reported herein was based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations were beyond the scope of this report unless reported otherwise.

In reviewing this report, it should be realized that the reported condition of the dam was based on observations of field conditions at the time of inspection, along with data available to the inspection team.

It is critical to note that the condition of the dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the reported condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

*Licensed Professional's Signature**

Christopher J. Cullen, P.E.
Massachusetts License No.: 47018
License Type: Civil



Project Manager
Fuss & O'Neill, Inc.

** 302 CMR 10.00 requires inspecting engineers to be Commonwealth of Massachusetts Registered Professional Engineers with a Civil Engineering license with experience in dam safety inspections and engineering. The Department will also accept inspection by a Commonwealth of Massachusetts Registered Professional Engineer with a Structural or Sanitary Engineering license, provided the Registered Professional Engineer has experience in the field of dam engineering and inspection.*



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SECTION 1

1.0 DESCRIPTION OF PROJECT

1.1 General

1.1.1 Authority

The Neponset River Land Holding Association (NRLHA) retained Fuss and O'Neill, Inc. to perform a visual inspection, and develop a report of conditions for Willett Pond Dam on Bubbling Brook in Walpole and Norwood, Norfolk County, Massachusetts. This inspection and report were performed in accordance with MGL Chapter 253, Sections 44-50 of the Massachusetts General Laws as amended by Chapter 330 of the Acts of 2002.

1.1.2 Purpose of Work

The purpose of this investigation was to inspect and evaluate the present condition of the dam and appurtenant structures in accordance with 302 CMR 10.07 to provide information that will assist in both prioritizing dam repair needs and planning/conducting maintenance and operation.

The investigation was divided into four parts: 1) obtain and review available reports, investigations, and data previously submitted to the owner pertaining to the dam and appurtenant structures; 2) perform a visual inspection of the site; 3) evaluate the status of an emergency action plan for the site and; 4) prepare and submit a final report presenting the evaluation of the structure, including recommendations and remedial actions, and opinion of probable costs.

1.1.3 Definitions

To provide the reader with a better understanding of the report, definitions of commonly used terms associated with dams are provided in Appendix D. Many of these terms may be included in this report. The terms are presented under common categories associated with dams which include: 1) orientation; 2) dam components; 3) size classification; 4) hazard classification; and 5) miscellaneous.

1.2 Description of Project

1.2.1 Location

The Willett Pond Dam is intersected by the town line between Walpole and Norwood in Norfolk County, Massachusetts. Brook Street in Norwood and Bullard Street in Walpole traverse the dam. The center of the dam is located at latitude 42.1812° North and Longitude 71.2330° West (WGS 84 Datum) as determined using Google Earth Software. The dike is located entirely within Walpole and begins several hundred feet south of the dam.

From the center of Norwood, travel south on Route 1A (Walpole Street). Turn Right on Bullard Street. The dam is approximately 1.3 miles from the Walpole Street/Bullard Street



intersection. The dike can be accessed by Bullard Lane, which is located approximately ¼ mile south of the dam.

The Willett Pond Dam drainage area is 4.8 square miles and is located within the towns of Norwood, Walpole, Westwood, and Dover. Hawes Brook discharges from Willett Pond and runs east to the head of Hawes Brook, which in turn runs east to the confluence with the Neponset River. The location of Willett Pond is shown in Figure 1. An aerial photograph of the dam and impoundment area is provided as Figure 2.

1.2.2 Owner/Caretaker

See Table 1.1 for current owner and caretaker data (names and contact information).

1.2.3 Purpose of the Dam

See Table 1.1 for the current purpose of the dam.

Willett Pond Dam was constructed in 1913 as a source for industrial water supply. The dam is currently being used for conservation and recreation.

1.2.4 Description of the Dam and Appurtenances

The dam is a 900-foot long earth embankment with a concrete core wall. The structural height of the dam is 25 feet. The downstream slope is approximately 2.5H:1V and grass-covered. The upstream slope is approximately 2H:1V and riprap covered. There is an asphalt-paved public road on the crest.

A spillway is located at the right abutment of the dam. The spillway is a concrete broad crested structure, 28.3 feet long with vertical concrete training walls. Two vertical feet of weir boards spanning the spillway in three bays are used to adjust water levels in the lake. A roadway bridge spans the spillway. The discharge channel is concrete and masonry lined with a concrete wall forming the left outlet wall and bedrock providing containment on the right side. The channel routes flow from the lake to a wetland downstream of the dam and ultimately to Bubbling Brook.

A brick gatehouse is located on the downstream slope of the dam. Within the gate house are two operators for slide gates controlling flow from the lake through two 20-inch ductile iron pipes. The pipes outlet to a concrete channel that routes water through a Parshall flume, and then to the wetland area downstream of the dam. The wetland area begins at the toe of the downstream embankment.

South of the dam, there is a 1,900-foot long dike with a structural height of approximately 14 feet. Like the dam, the dike is an earth embankment with a concrete core wall. There is residential development abutting the full length of the dike. The crest of the dike is generally 15 feet wide and grass-covered. The upstream slope is generally 2H:1V, and riprap covered with several small boat docks serving the residences. The downstream slope varies considerably, from approximately 3H:1V to flat, where residential filling against the downstream slope has brought the grade up to the crest elevation.



1.2.5 Operations and Maintenance

The NRLHA currently manages operation and maintenance activities on the dam and dike. There is a formal Operation & Maintenance (O&M) Manual, last updated in March 2016. NRLHA also maintains a logbook with water surface elevations, stop log position, valve adjustments, and other maintenance activities. The O&M Manual describes operational goals and maintenance schedules by time of year. NRLHA appears to be following their O&M manual guidelines.

1.2.6 DCR Size Classification

Willet Pond Dam has a height of dam of approximately 25 feet and a maximum storage capacity of 2,500 acre-feet. Refer to Appendix D for definitions of height of dam and storage. Therefore, in accordance with Department of Conservation and Recreation Office of Dam Safety classification, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, Willet Pond Dam is a Large size structure.

1.2.7 DCR Hazard Potential Classification

The areas surrounding Bubbling Brook and the Neponset River below Willett Pond Dam, are heavily developed with residential areas and multiple commercial and industrial complexes, parks, and schools. It appears that a failure of the dam at maximum pool will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s). Therefore, in accordance with Department of Conservation and Recreation classification procedures, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, Willett Pond Dam should be classified as a **High (Class I)** hazard potential dam. The Hazard Potential Classification recommendation is consistent with the Hazard Potential Classification on record with the Office of Dam Safety for Willett Pond Dam.

1.3 Pertinent Engineering Data

1.3.1 Drainage Area

The drainage area for Willett Pond Dam is approximately 4.8 square miles as delineated and confirmed using USGS StreamStats online software and extends through the communities of Norwood, Walpole, Westwood, and Dover. The topography is gently rolling. Portions of the watershed are heavily developed. Approximately 45 percent of the watershed is made up of farms, woodlands, and swamps. No significant impoundments are located within the watershed.

1.3.2 Reservoir

See Table 1.1 for data about normal, maximum, and spillway design flood (SDF) pools.

1.3.3 Discharges at the Dam Site

No record of discharges was available for this site. No records of overtopping were discovered during the research for this report.



1.3.4 General Elevations (feet)

A. Top of Dam	145.0
B. Spillway Design Flood Pool	>145.0
C. Normal Pool (With weir boards)	139.9
D. Spillway Crest (No weir boards)	137.7
E. Top of Dike	142.0
F. Upstream Water at Time of Inspection	140.0
G. Downstream Water at Time of Inspection	120.5
H. Streambed at Toe of the Dam	119.5
I. Low Point along Toe of the Dam	119.5 at low level outlet

1.3.5 Main Spillway Data

A. Type	Concrete spillway with 3 bays of weir boards
B. Weir Length	28.3 feet
C. Weir Crest Elevation	139.9
D. Upstream Channel	137.7
E. Downstream Channel	137.5

The spillway travels through the bridge abutments under Bullard Street. A channel with an average slope of 8 percent carries the water to the confluence with Bubbling Brook.

1.3.6 Auxiliary Outlet

A. Type	Low-level
B. Size	20-inch diameter iron pipes (2)
C. Invert of Pipes	119.64
D. Control	Knife Gates

1.3.7 Design and Construction Records and History

The dam was constructed in 1913. As-built drawings were included in the 1979 ACOE Phase I Report. Repair plans and as-built plans for the Bullard Street Bridge Repair are also on file.

Maintenance of the dam since the 2015 inspection has included:

- Brush and small tree removal from the dike
- Removal of debris from the spillway discharge channel
- Exercising the gates twice per year

1.3.8 Operating Records

Operations records for the dam are kept in a log book. Maintenance items, stop-log configuration, low-level outlet configuration, and pond elevations are routinely recorded during site visits.

1.4 Summary Data Table

1.1 Summary Data Table

Required Phase I Report Data	Data Provided by the Inspecting Engineer
National ID #	MA00169
Dam Name	Willett Pond Dam and Dike
Dam Name (Alternate)	0
River Name	Bubbling Brook
Impoundment Name	Willett Pond
Hazard Class	High
Size Class	Large
Dam Type	Earth Embankment
Dam Purpose	Recreation/Conservation
Structural Height of Dam (feet)	25
Hydraulic Height of Dam (feet)	20
Drainage Area (sq. mi.)	4.8
Reservoir Surface Area (acres)	240
Normal Impoundment Volume (acre-feet)	1736
Max Impoundment Volume ((top of dam) acre-feet)	2500
SDF Impoundment Volume* (acre-feet)	>2500
Spillway Type	Box Culvert/Channel
Spillway Length (feet)	28.3
Freeboard at Normal Pool (feet)	5
Principal Spillway Capacity* (cfs)	250/650 (with/without stop logs)
Auxiliary Spillway Capacity* (cfs)	N/A
Low-Level Outlet Capacity* (cfs)	96 (at max pool)
Spillway Design Flood* (flow rate - cfs)	1/2PMF, 4,830
Winter Drawdown (feet below normal pool)	NA
Drawdown Impoundment Vol. (acre-feet)	NA
Latitude	42.1812N
Longitude	71.233W
City/Town	Norwood
County Name	Norfolk
Public Road on Crest	Yes
Public Bridge over Spillway	Yes
EAP Date (if applicable)	3/17/2016
Owner Name	Neponset River Land Holding Assoc.
Owner Address	2173 Washington Street
Owner Town	Canton, MA 02021
Owner Phone	781-575-0354
Owner Emergency Phone	781-575-0354
Owner Type	Private Association or other non-profit
Caretaker Name	Tom Palmer & Ian Cooke
Caretaker Address	2173 Washington Street
Caretaker Town	Canton, MA 02021
Caretaker Phone	781-575-0354
Caretaker Emergency Phone	978-467-5271
Date of Field Inspection	6/6/2017
Consultant Firm Name	Fuss & O'Neill, Inc.
Inspecting Engineer	Shawn King
Engineer Phone Number	860-646-2469

*In the event a hydraulic and hydrologic analysis has not been completed for the dam, indicate "No H&H" in this table, recommendation section shall include specific recommendation to hire a qualified dam engineering consultant to conduct analysis to determine spillway adequacy in conformance with 302 CMR 10.00.



SECTION 2

2.0 INSPECTION

2.1 Visual Inspection

Willett Pond Dam was inspected on June 6, 2017. At the time of the inspection, the weather was 85°F and clear. Photographs to document the current conditions of the dam were taken during the inspection and are included in Appendix A. The level of the impoundment was 140.0 feet (normal pool). Underwater areas were not inspected. A copy of the inspection checklist is included in Appendix B.

2.1.1 General Findings

In general, Willett Pond Dam was found to be in **Poor** condition due to the inadequate spillway size. If the spillway were adequately sized, this dam would be classified to be Fair or possibly Satisfactory. The specific concerns are identified in more detail in the sections below:

2.1.2 Dam

- ***Abutments***
 - The abutments were in satisfactory condition.
- ***Upstream Slope***
 - The upstream face of the dam is an earthen slope with armor consisting of placed rip-rap.
- ***Crest***
 - The roadway on the dam crest was raised approximately two feet at some point in the past, so the original dam crest is not visible. The asphalt roadway is cracked and rutted with age. There are some signs of the road base course eroding in places.
- ***Downstream Slope***
 - The downstream slope is approximately 2.5:1 with satisfactory vegetative cover.

2.1.3 Appurtenant Structures

- ***Primary Spillway***

The spillway structure has a concrete floor and side walls. A steel and concrete bridge spans the spillway. The base of the spillway is concrete. The upper half of the structure and upstream training walls are formed and poured concrete and in good condition. Two concrete pier remnants are located within the spillway. These piers are part of the old bridge structure that was left in place when the Bullard Street Bridge was reconstructed in 2007. The piers support three bays of wooden weir boards that appeared to be in good condition. No seepage was observed below or around the spillway.



- ***Low-Level Outlet***

The low-level outlet consists of two 20-inch diameter ductile iron pipes. The outlets are controlled by knife gates located in a gatehouse on the downstream slope of the dam. The gates are typically left in a partially open position to maintain minimum flows to Bubbling Brook and the Neponset River. The valve operators are regularly maintained. A Parshall flume is located at the discharge of the low level outlet pipes.

- ***Dike***

The dike consists of a 1,900-foot-long earthen embankment with a concrete core wall. Abutting property owners have historically accessed Willett Pond across the dike. Small birch trees are located along approximately 40 percent of the waterline and upstream face of the dike. The crests of the dike and the downstream slope have varying degrees of vegetation, but the majority of the dike is covered with grass. It was noted that areas of sparse vegetation observed in the past are establishing vegetation during this inspection, but additional areas were observed with little to no vegetation. Riprap protection was observed on much of the upstream dike embankment. In some areas, abutters have effectively buttressed the dike by substantially filling the areas down gradient of the dike. In other areas the downstream slope of the dike has slopes as steep as 2:1.

2.1.4 Downstream Area

The area immediately below the dam is primarily wetland and marsh with thick brush and small streams. Guild Pond is located approximately 300 feet downstream of the dam.

2.1.5 Reservoir Area

- The shores of Willett Pond are generally mild to medium sloped. The shores are a mix of well-maintained lawns at private residences and wooded areas elsewhere.

2.2 Caretaker Interview

Mr. Ian Cooke of NRLHA provided updated information concerning activities, maintenance operation of the dam and dike. The information provided by them has been incorporated into this report. Information of note includes:

- No Dam or Dike overtopping events are indicated in their records
- The dam is managed as part of the Neponset River Watershed for conservation and recreation
- An O&M Manual is kept up to date
- Staff is regularly trained and is knowledgeable about maintenance and emergency procedures
- An Emergency Action Plan (EAP) is on file with the Office of Dam Safety
- As-Built Plans are available



2.3 Operation and Maintenance Procedures

NRLHA keeps an updated O&M Manual. The manual was last updated in March 2016, with the addition of the EAP as an addendum to the O&M manual.

2.3.1 Operational Procedures

The O&M Plan establishes goals for operation of the dam. The basic operational goal is to ensure adequate flow for fish spawning, survival, and overwintering while maintaining an adequate pool for recreation on the pond. The plan divides the year into three periods and establishes minimum discharges and target pond water levels for each period. The O&M Plan references the EAP for additional emergency operation procedures.

The low level outlet gates are lubricated and exercised every spring and fall by opening and closing the valves fully before returning them to their appropriate seasonal settings.

2.3.2 Maintenance of Dam and Operating Facilities

The plan defines four maintenance priorities, including:

- Maintaining the ground cover on the dam and dike with periodic grass planting and mowing, preventing erosion and allowing for efficient dam inspection.
- Scheduling regular tree and brush cutting and spraying stumps to prevent roots from penetrating the dam and dike.
- Keeping the spillway clear and maintaining the desired flow.
- Maintaining the integrity of the valve house and exercising the valves.

The plan calls for dam visits as necessary to meet seasonal operational goals, with monthly inspections from March through November, and one winter inspection in January. Additionally, the plan calls for inspections prior to or after extraordinary weather events, such as: prior to predicted major rainstorms or snow melts, during or after extremely heavy rainfall or a severe storm, during or after a severe windstorm, and following an earthquake in the area.

Specific tasks addressed in the plan include:

- Trash pick-up, annually on Earth Day and at other times as deemed necessary.
- Exercising low-level outlet valves each spring and fall.
- Filling, marking, and monitoring animal holes and removal of nuisance animals as necessary.
- Inspecting, realigning, and replacing erosion control wattles as necessary each May and October.
- Spot seeding every April and September as needed.
- Mowing of warm season grass in May, June, August, and September or as needed.
- Spraying weeds and poison ivy with herbicide or manually removing monthly or as necessary.
- Spraying woody vegetation on the water side of dike and dam with herbicide in September, if needed.



- Cutting woody vegetation to the ground after it has been killed.
- Removing obstructions from the spillway during monthly inspections.
- Repairing dislodged riprap as needed.

2.4 Emergency Warning System

A formal EAP, last updated in 2016, is on file with the DCR Office of Dam Safety, the local Emergency Management Office, and in the NRLHA offices.

2.5 Hydrologic/Hydraulic Data

Willett Pond Dam is classified as a Large size, High hazard (Class I) potential dam and in accordance with the MGL 302 CMR 10.00, the spillway design flood is the ½-PMF flood event.

The information in the table below was obtained from our hydrologic and hydraulic assessment of the dam performed as part of the Phase II Investigation. The numbers presented represent the spillway capacity without weir boards in place. Peak SDF inflow was estimated at 4,883 cfs. The routed SDF outflow was estimated at 4,811 cfs without weir boards and 4,830 with weir boards installed.

A. Spillway Design Flood (SDF) Return Period	½ PMF
B. SDF Inflow (cfs)	4,883 cfs
C. SDF Outflow (cfs)	4,830 cfs
D. Principal Spillway Capacity (cfs)(no weir boards)	650 cfs
E. Low-level Outlet Capacity (cfs)	96 cfs
F. Maximum Depth of Overtopping for SDF (ft) (if applicable)	1.8 ft

There are no records of embankment overtopping at the dam or dike. However, our study of the dam indicates the dike will overtop by as much as 1.8 feet during the SDF.

2.6 Structural and Seepage Stability

Stability and seepage analyses were performed as part of the 2011 Phase II Investigation performed by Fuss & O'Neill.

2.6.1 Embankment Structural Stability

Dam embankment stability analyses performed as part of the recent Phase II investigation indicated factors of safety of 1.5 against deep failure under full pool conditions and 1.16 under seismic, full pool conditions.



2.6.2 Seepage Stability

The toe of the dam, and three locations along the toe of the dike (as shown in the figures) are damp, but no seepage flow was noted. The moist conditions at the toe of the dam are most likely due to backwater from the wetland and pond immediately downstream of the dam. The seepage observed at the toe of the dike does not appear to be causing any instability. The wet areas at the toe of the dike all correspond to drainage collection areas at the toe and are not likely due to seepage. No subsidence, sinkholes or sediment transport was noted during the inspection.

The core walls in the dam and dike have a significant effect on seepage. Monitoring well elevations and seepage analysis of the dam during the Phase II investigation indicated that the core walls are performing adequately.



SECTION 3

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

In general, the overall condition of Willett Pond Dam is **Poor**, primarily due to the low spillway capacity. The dam was found to have the following deficiencies:

1. Spillway Capacity only capable of passing approximately 13 percent of the Spillway Design Flood (SDF) without overtopping
2. Minor irregularities of dike crest height
3. Sparse vegetation cover in areas on dike
4. Woody vegetation on dike

The 2015 Phase I Report listed the condition of Willett Pond Dam as Poor. The table below lists the previously identified deficiencies and the current status of those deficiencies:

Previously Identified Deficiency	Resolution or Current Condition
Spillway Capacity only capable of passing approximately 13 percent of the Spillway Design Flood (SDF) without overtopping	Unresolved – Alternatives provided in the Phase II investigation
Minor irregularities of dike crest height	Unresolved – Irregularities remain
Sparse vegetative cover on dike	Partially Resolved – Some areas reestablishing cover.
Woody vegetation on dike	Unresolved – Woody vegetation persists on dike

The following recommendations and remedial measures generally describe the recommended approach to address current deficiencies at the dam. Prior to undertaking recommended maintenance, repairs, or remedial measures, the applicability of environmental permits needs to be determined for activities that may occur within resource areas under the jurisdiction of local conservation commissions, MADEP, or other regulatory agencies.

3.2 Studies and Analyses

The Phase II Report has been completed in 2011. Alternatives for rehabilitation of the dam were provided, principally involving the inadequate capacity of the spillway to accommodate the SDF. No additional studies are recommended at this time.



3.3 Recurrent Maintenance Recommendations

The annual maintenance procedures indicated in the O&M Manual should continue to be followed. The primary tasks from the plan include:

- Exercising low-level outlet valves each spring and fall.
- Filling, marking, and monitoring animal holes and removal of nuisance animals as necessary.
- Inspecting, realigning, and replacing erosion control wattles as necessary each May and October.
- Spot seeding every April and September as needed.
- Mowing of warm season grass in May, June, August, and September.
- Spraying weeds and poison ivy with herbicide monthly or as necessary.
- Spraying woody vegetation on the water side of dike and dam with herbicide in September when needed.
- Cutting woody vegetation to the ground after it has been killed.
- Removing obstructions from the spillway during monthly inspections.

3.4 Minor Repair Recommendations

- Remove woody vegetation, especially non-birch varieties, from dike

3.5 Remedial Modifications Recommendations

The only major remedial recommendation concerns the inadequacy of the spillway to accommodate the design storm, which is the 1/2 PMF for High Hazard dams. This issue has been addressed in the Phase II investigation.

3.6 Alternatives

As stated above, the spillway capacity issue was examined in the Phase II investigation. Several alternatives were presented, including breaching the dam, widening and/or deepening the spillway, raising the dike elevation, raising the dam elevation, armoring the dike to overtop safely, installing a new weir, installing a new gate and combinations of these. It has been determined that the cross sectional area beneath the bridge needs to be increased in area to accommodate the SDF under any scenario. The fixed spillway length must be increased to 350 feet. Alternatively, a bottom-hinged gate is also being considered. At this time, alternative spillway solutions are being considered.



3.7 Opinion of Probable Construction Costs

Costs for repair of the dam are dominated by the cost of providing adequate spillway capacity for the SDF. Costs for several spillway alternatives were presented in the Phase II investigation. All costs included enlarging the cross-sectional bridge opening area. The following table summarizes the cost ranges for each alternative considered.

Spillway Alternative	Cost Range		
Hinged bottom gate	\$1,046,000	-	\$2,240,000
Long fixed concrete ogee weir	\$2,292,000	-	\$4,910,000
Raise dike, short ogee weir	\$1,299,000	-	\$2,783,000
Lower water level, short ogee weir	\$1,209,000	-	\$2,591,000



FIGURES

Figure 1.	Locus Plan
Figure 2.	Aerial Photograph
Figure 3.	Drainage Area
Figure 4.	Downstream Area
Figure 5.	Site Sketch (Dam)
Figure 6.	Site Sketch (Dike)
Figure 7.	Dam Photo (Dam)
Figure 8.	Photo Key (Dike)



APPENDIX A

Photographs



Photo 1: Overview of dam from downstream



Photo 2: Overview of upstream face from right abutment



Photo 3: Overview of upstream face from left abutment



Photo 4: Overview of dam crest from right abutment



Photo 5: Overview of dam crest from left abutment



Photo 6: Overview downstream face from right abutment



Photo 7: Overview of downstream face from left abutment



Photo 8: Overview of spillway from upstream



Photo 9: Overview of spillway from downstream



Photo 10: Overview of right training wall



Photo 11: Overview of left training wall



Photo 12: Overview of weir



Photo 13: Overview of stilling basin



Photo 14: Overview of downstream channel



Photo 15: Overview of gatehouse exterior



Photo 16: Overview of gatehouse interior



Photo 17: Overview of knife gate valve operator #1 (note leakage)



Photo 18: Overview of knife gate valve operator #2



Photo 19: Overview of operational stem



Photo 20: Overview of Parshall Flume outlet exterior



Photo 21: Overview of Parshall Flume outlet channel and downstream area



Photo 22: Overview of reservoir



Photo 23: Dike crest facing left abutment



Photo 24: Dike upstream slope facing left abutment



Photo 25: Overview of dike crest



Photo 26: Overview of dike crest



Photo 27: Overview of dike crest



Photo 28: Overview of dike crest



Photo 29: Overview of dike crest



Photo 30: Overview of dike crest



Photo 31: Overview of dike crest



Photo 32: Overview of dike crest



Photo 33: Overview of dike crest



Photo 34: Dike crest facing right abutment



Photo 35: Panoramic view of downstream dam face




APPENDIX B

Inspection Checklist

DAM SAFETY INSPECTION CHECKLIST

NAME OF DAM: <u>Willett Pond Dam and Dike</u>		STATE ID #: <u>6-11-220-02</u>
REGISTERED: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	NID ID #: <u>MA00169</u>	
STATE SIZE CLASSIFICATION: <u>Large</u>		STATE HAZARD CLASSIFICATION: <u>High</u>
		CHANGE IN HAZARD CLASSIFICATION REQUESTED?: <u>No</u>
<u>DAM LOCATION INFORMATION</u>		
CITY/TOWN: <u>Norwood</u>	COUNTY: <u>Norfolk</u>	
DAM LOCATION: (street address if known) <u>Brook Street (Norwood), Bullard Street (Walpole)</u>	ALTERNATE DAM NAME: _____	
USGS QUAD.: <u>Norwood</u>	LAT.: <u>42.1812N</u>	LONG.: <u>71.233W</u>
DRAINAGE BASIN: <u>Boston Harbor</u>	RIVER: <u>Bubbling Brook</u>	
IMPOUNDMENT NAME(S): <u>Willett Pond</u>		
<u>GENERAL DAM INFORMATION</u>		
TYPE OF DAM: <u>Earth Embankment</u>	OVERALL LENGTH (FT): <u>800</u>	
PURPOSE OF DAM: <u>Recreation/Conservation</u>	NORMAL POOL STORAGE (ACRE-FT): <u>1736</u>	
YEAR BUILT: <u>1913</u>	MAXIMUM POOL STORAGE (ACRE-FT): <u>2500</u>	
STRUCTURAL HEIGHT (FT): <u>25</u>	EL. NORMAL POOL (FT): <u>139.9</u>	
HYDRAULIC HEIGHT (FT): <u>20</u>	EL. MAXIMUM POOL (FT): <u>142 (dike crest height)</u>	
<u>FOR INTERNAL MADCR USE ONLY</u>		
FOLLOW-UP INSPECTION REQUIRED: <input type="checkbox"/> YES <input type="checkbox"/> NO	CONDITIONAL LETTER: <input type="checkbox"/> YES <input type="checkbox"/> NO	

NAME OF DAM: <u>Willett Pond Dam and Dike</u>		STATE ID #: <u>6-11-220-02</u>	
INSPECTION DATE: <u>June 6, 2017</u>		NID ID #: <u>MA00169</u>	
<u>INSPECTION SUMMARY</u>			
DATE OF INSPECTION: <u>June 6, 2017</u>		DATE OF PREVIOUS INSPECTION: <u>July 7, 2015</u>	
TEMPERATURE/WEATHER: <u>85°F, Clear</u>		ARMY CORPS PHASE I: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO If YES, date <u>April, 1979</u>	
CONSULTANT: <u>Fuss & O'Neill, Inc.</u>		PREVIOUS DCR PHASE I: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO If YES, date <u>7-Jul-15</u>	
BENCHMARK/DATUM: <u>NGVD29</u>			
OVERALL PHYSICAL CONDITION OF DAM: <u>POOR</u>		DATE OF LAST REHABILITATION: <u>Fall 2007-Spring 2008</u>	
SPILLWAY CAPACITY: <u>0-50% of the SDF or Unknown</u>			
EL. POOL DURING INSP.: <u>140</u>		EL. TAILWATER DURING INSP.: <u>120.5</u>	
<u>PERSONS PRESENT AT INSPECTION</u>			
<u>NAME</u>	<u>TITLE/POSITION</u>	<u>REPRESENTING</u>	
Shawn King	Project Engineer	Fuss & O'Neill	
<u>EVALUATION INFORMATION</u>			
Click on box to select E-code		Click on box to select E-code	
E1) TYPE OF DESIGN	3	E8) LOW-LEVEL OUTLET CONDITION	5
E2) LEVEL OF MAINTENANCE	4	E9) SPILLWAY DESIGN FLOOD CAPACITY	1
E3) EMERGENCY ACTION PLAN	5	E10) OVERALL PHYSICAL CONDITION	2
E4) EMBANKMENT SEEPAGE	5	E11) ESTIMATED REPAIR COST	\$1,046,900 - \$4,910,000
E5) EMBANKMENT CONDITION	4	ROADWAY OVER CREST	YES
E6) CONCRETE CONDITION	4	BRIDGE NEAR DAM	YES
E7) LOW-LEVEL OUTLET CAPACITY	4		
NAME OF INSPECTING ENGINEER: <u>Chris Cullen</u>		SIGNATURE: 	

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #:	6-11-220-02																																				
INSPECTION DATE: June 6, 2017		NID ID #:	MA00169																																				
<table border="0"> <tr> <td>OWNER:</td> <td>ORGANIZATION</td> <td>CARETAKER:</td> <td>ORGANIZATION</td> </tr> <tr> <td></td> <td>NAME/TITLE</td> <td></td> <td>NAME/TITLE</td> </tr> <tr> <td></td> <td>STREET</td> <td></td> <td>STREET</td> </tr> <tr> <td></td> <td>TOWN, STATE, ZIP</td> <td></td> <td>TOWN, STATE, ZIP</td> </tr> <tr> <td></td> <td>PHONE</td> <td></td> <td>PHONE</td> </tr> <tr> <td></td> <td>EMERGENCY PH. #</td> <td></td> <td>EMERGENCY PH. #</td> </tr> <tr> <td></td> <td>FAX</td> <td></td> <td>FAX</td> </tr> <tr> <td></td> <td>EMAIL</td> <td></td> <td>EMAIL</td> </tr> <tr> <td></td> <td>OWNER TYPE</td> <td></td> <td></td> </tr> </table>				OWNER:	ORGANIZATION	CARETAKER:	ORGANIZATION		NAME/TITLE		NAME/TITLE		STREET		STREET		TOWN, STATE, ZIP		TOWN, STATE, ZIP		PHONE		PHONE		EMERGENCY PH. #		EMERGENCY PH. #		FAX		FAX		EMAIL		EMAIL		OWNER TYPE		
OWNER:	ORGANIZATION	CARETAKER:	ORGANIZATION																																				
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	EMERGENCY PH. #		EMERGENCY PH. #																																				
	FAX		FAX																																				
	EMAIL		EMAIL																																				
	OWNER TYPE																																						
	Neponset River Land Holding Ass Ian Cooke, President		Neponset River Land Holding Assoc. Tom Palmer & Ian Cooke																																				
	2173 Washington Street		2173 Washington Street																																				
	Canton, MA 02021		Canton, MA 02021																																				
	781-575-0354		781-575-0354																																				
	781-575-0354		978-467-5271																																				
	781-575-9971		781-575-9971																																				
	cooke@neponset.org		palmer@neponset.org																																				
	Private Association or other non-profit																																						
PRIMARY SPILLWAY TYPE Box Culvert/Channel																																							
SPILLWAY LENGTH (FT)	28.3	SPILLWAY CAPACITY (CFS)	250/650 (with/without stop logs)																																				
AUXILIARY SPILLWAY TYPE	N/A	AUX. SPILLWAY CAPACITY (CFS)	N/A																																				
NUMBER OF OUTLETS	2	OUTLET(S) CAPACITY (CFS)	96 (at max pool)																																				
TYPE OF OUTLETS	20-inch diameter ductile iron pipes (2)	TOTAL DISCHARGE CAPACITY (CFS)	346/746 (With/without stop logs)																																				
DRAINAGE AREA (SQ MI)	4.8	SPILLWAY DESIGN FLOOD (PERIOD/CFS)	1/2PMF, 4,830																																				
HAS DAM BEEN BREACHED OR OVERTOPPED	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO	IF YES, PROVIDE DATE(S)																																					
FISH LADDER (LIST TYPE IF PRESENT)																																							
DOES CREST SUPPORT PUBLIC ROAD?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	IF YES, ROAD NAME:	Brook St (Norwood) and Bullard st. (Walpole)																																				
PUBLIC BRIDGE WITHIN 50' OF DAM?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	IF YES, ROAD/BRIDGE NAME:	Brook St (Norwood) and Bullard st. (Walpole)																																				
		MHD BRIDGE NO. (IF APPLICABLE)	BR#W-03-037(3KC)																																				

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02	
INSPECTION DATE: June 6, 2017		NID ID #: MA00169	
EMBANKMENT (CREST)			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
CREST	1. SURFACE TYPE	Paved Road	X
	2. SURFACE CRACKING	Numerous cracks in pavement; patched	X
	3. SINKHOLES, ANIMAL BURROWS	None observed	X
	4. VERTICAL ALIGNMENT (DEPRESSIONS)	Minor - gradual changes along dam crest	X
	5. HORIZONTAL ALIGNMENT	Good	X
	6. RUTS AND/OR PUDDLES	Some rutting of pavement	X
	7. VEGETATION (PRESENCE/CONDITION)	Paved road	X
	8. ABUTMENT CONTACT	Good	X
ADDITIONAL COMMENTS: The dam crest cannot be observed because a paved road with base course has been constructed on the original dam crest.			

NAME OF DAM: <u>Willett Pond Dam and Dike</u>		STATE ID #: <u>6-11-220-02</u>			
INSPECTION DATE: <u>June 6, 2017</u>		NID ID #: <u>MA00169</u>			
EMBANKMENT (D/S SLOPE)					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S SLOPE	1. WET AREAS (NO FLOW)	Wet areas along significant portion of toe likely due to downstream wetland		X	
	2. SEEPAGE	None Observed	X		
	3. SLIDE, SLOUGH, SCARP	None Observed	X		
	4. EMB.-ABUTMENT CONTACT	Some stone and misc. fill at the left dam/abutment contact	X		
	5. SINKHOLE/ANIMAL BURROWS	None Observed	X		
	6. EROSION	None Observed	X		
	7. UNUSUAL MOVEMENT	None Observed	X		
	8. VEGETATION (PRESENCE/CONDITION)	Good	X		
ADDITIONAL COMMENTS:					

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02	
INSPECTION DATE: June 6, 2017		NID ID #: MA00169	
<div> <div>EMBANKMENT (U/S SLOPE)</div> </div>			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
U/S SLOPE	1. SLIDE, SLOUGH, SCARP	None Observed	X
	2. SLOPE PROTECTION TYPE AND COND.	Placed rip-rap along upstream face in good condition (see notes)	X
	3. SINKHOLE/ANIMAL BURROWS	None Observed	X
	4. EMB.-ABUTMENT CONTACT	Good	X
	5. EROSION	None Observed	X
	6. UNUSUAL MOVEMENT	None Observed	X
	7. VEGETATION (PRESENCE/CONDITION)	Riprap, no vegetation	X
ADDITIONAL COMMENTS: Flat placed large stones on upstream face. Road crest appears to have been raised by placing fill over original dam crest. This 2' of fill has an irregular edge that may be subject to erosion from wave action. Any erosion would affect the road condition, but would likely not adversely impact the dam.			

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02	
INSPECTION DATE: June 6, 2017		NID ID #: MA00169	
INSTRUMENTATION			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
INSTR.	1. PIEZOMETERS	2 piezometers were installed along dam crest (up and downstream of internal core wall)	X
	2. OBSERVATION WELLS	N/A	
	3. STAFF GAGE AND RECORDER	N/A	
	4. WEIRS	N/A	
	5. INCLINOMETERS	N/A	
	6. SURVEY MONUMENTS	N/A	
	7. DRAINS	N/A	
	8. FREQUENCY OF READINGS	N/A	
	9. LOCATION OF READINGS	N/A	
ADDITIONAL COMMENTS: 2 piezometers were also located on dike near left and right abutments			

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02	
INSPECTION DATE: June 6, 2017		NID ID #: MA00169	
DOWNSTREAM MASONRY WALLS			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
D/S WALLS	1. WALL TYPE	N/A	
	2. WALL ALIGNMENT	N/A	
	3. WALL CONDITION	N/A	
	4. HEIGHT: TOP OF WALL TO MUDLINE	min: max: avg:	
	5. SEEPAGE OR LEAKAGE	N/A	
	6. ABUTMENT CONTACT	N/A	
	7. EROSION/SINKHOLES BEHIND WALL	N/A	
	8. ANIMAL BURROWS	N/A	
	9. UNUSUAL MOVEMENT	N/A	
	10. WET AREAS AT TOE OF WALL	N/A	
ADDITIONAL COMMENTS:			

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02	
INSPECTION DATE: June 6, 2017		NID ID #: MA00169	
UPSTREAM MASONRY WALLS			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
U/S WALLS	1. WALL TYPE	N/A	
	2. WALL ALIGNMENT	N/A	
	3. WALL CONDITION	N/A	
	4. HEIGHT: TOP OF WALL TO MUDLINE	min: max: avg:	
	5. ABUTMENT CONTACT	N/A	
	6. EROSION/SINKHOLES BEHIND WALL	N/A	
	7. ANIMAL BURROWS	N/A	
	8. UNUSUAL MOVEMENT	N/A	
ADDITIONAL COMMENTS:			

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02	
INSPECTION DATE: June 6, 2017		NID ID #: MA00169	
DOWNSTREAM AREA			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
D/S AREA	1. ABUTMENT LEAKAGE	None Observed	X
	2. FOUNDATION SEEPAGE	None Observed	X
	3. SLIDE, SLOUGH, SCARP	None Observed	X
	4. WEIRS	None Observed	X
	5. DRAINAGE SYSTEM	None Observed	X
	6. INSTRUMENTATION	Parshall Flume Downstream of Gate House	X
	7. VEGETATION	Heavy vegetation, lots of brush	X
	8. ACCESSIBILITY	No ready access, except by foot	X
9. DOWNSTREAM HAZARD DESCRIPTION		Developed residential with some industrial and commercial	
10. DATE OF LAST EAP UPDATE		3/17/2016	
ADDITIONAL COMMENTS:			

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02
INSPECTION DATE: June 6, 2017		NID ID #: MA00169
MISCELLANEOUS		
AREA INSPECTED	CONDITION	OBSERVATIONS
MISC.	1. RESERVOIR DEPTH (AVG)	Unknown
	2. RESERVOIR SHORELINE	Private residences, primarily. Some undeveloped
	3. RESERVOIR SLOPES	Mild to moderate
	4. ACCESS ROADS	Bullard Street in Walpole, Brook street in Norwood
	5. SECURITY DEVICES	Gate house is triple locked
	6. VANDALISM OR TRESPASS	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO WHAT:
	7. AVAILABILITY OF PLANS	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: ACOE Phase 1 - April 1979
	8. AVAILABILITY OF DESIGN CALCS	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: ACOE Phase 1 - April 1979
	9. AVAILABILITY OF EAP/LAST UPDATE	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: 3/17/2016
	10. AVAILABILITY OF O&M MANUAL	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: June 4, 2013
	11. CARETAKER/OWNER AVAILABLE	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: June 6, 2017
	12. CONFINED SPACE ENTRY REQUIRED	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO PURPOSE:
ADDITIONAL COMMENTS: EAP was updated in 2016		

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02	
INSPECTION DATE: June 6, 2017		NID ID #: MA00169	
PRIMARY SPILLWAY			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
SPILLWAY	SPILLWAY TYPE	Concrete channel with vertical side walls	X
	WEIR TYPE	2 ft high stop logs	X
	SPILLWAY CONDITION	Fair	X
	TRAINING WALLS	Good	X
	SPILLWAY CONTROLS AND CONDITION	Wooden stop logs	X
	UNUSUAL MOVEMENT	None observed	X
	APPROACH AREA	Willet Pond - clear of debris	X
	DISCHARGE AREA	Stone lined channel, some concrete paving of channel	X
	DEBRIS	None observed	X
	WATER LEVEL AT TIME OF INSPECTION	Approximately 1" of flow over stop-logs el. 140.0 feet	X
ADDITIONAL COMMENTS: Spillway is undersized to pass the SDF			

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02
INSPECTION DATE: June 6, 2017		NID ID #: MA00169
AUXILIARY SPILLWAY		
AREA INSPECTED	CONDITION	OBSERVATIONS
SPILLWAY	SPILLWAY TYPE	N/A
	WEIR TYPE	N/A
	SPILLWAY CONDITION	N/A
	TRAINING WALLS	N/A
	SPILLWAY CONTROLS AND CONDITION	N/A
	UNUSUAL MOVEMENT	N/A
	APPROACH AREA	N/A
	DISCHARGE AREA	N/A
	DEBRIS	N/A
	WATER LEVEL AT TIME OF INSPECTION	N/A
ADDITIONAL COMMENTS:		

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02			
INSPECTION DATE: June 6, 2017		NID ID #: MA00169			
OUTLET WORKS					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
OUTLET WORKS	TYPE	Two 20-inch ductile iron pipes	X		
	INTAKE STRUCTURE	Submerged, not visible	X		
	TRASHRACK	Unknown	X		
	PRIMARY CLOSURE	Gate valves located within gate house near downstream toe, minor leakage		X	
	SECONDARY CLOSURE	N/A	X		
	CONDUIT	Two 20-inch ductile iron pipes	X		
	OUTLET STRUCTURE/HEADWALL	Discharge to concrete Parshall flume	X		
	EROSION ALONG TOE OF DAM	None observed	X		
	SEEPAGE/LEAKAGE	Minor leakage from gate valve housings		X	
	DEBRIS/BLOCKAGE	None observed	X		
UNUSUAL MOVEMENT	None observed	X			
DOWNSTREAM AREA	Heavily vegetated stream discharging to a small pond on Hawes brook	X			
MISCELLANEOUS					
ADDITIONAL COMMENTS: Sump pipe from gate house to the downstream wetland is broken inside the concrete chamber upstream of the Parshall Flume, allowing water in the flume to back up into the gate house. Temporary repair of pipe has been performed by NHLA					

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02			
INSPECTION DATE: June 6, 2017		NID ID #: MA00169			
CONCRETE/MASONRY DAMS					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
GENERAL	TYPE	N/A			
	AVAILABILITY OF PLANS	N/A			
	AVAILABILITY OF DESIGN CALC'S	N/A			
	PIEZOMETERS	N/A			
	OBSERVATION WELLS	N/A			
	INCLINOMETERS	N/A			
	SEEPAGE GALLERY	N/A			
	UNUSUAL MOVEMENT	N/A			
ADDITIONAL COMMENTS:					

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #:	6-11-220-02		
INSPECTION DATE: June 6, 2017		NID ID #:	MA00169		
CONCRETE/MASONRY DAMS (CREST)					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	TYPE	N/A			
	SURFACE CONDITIONS	N/A			
	CONDITIONS OF JOINTS	N/A			
	UNUSUAL MOVEMENT	N/A			
	HORIZONTAL ALIGNMENT	N/A			
	VERTICAL ALIGNMENT	N/A			
ADDITIONAL COMMENTS:					

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02	
INSPECTION DATE: June 6, 2017		NID ID #: MA00169	
CONCRETE/MASONRY DAMS (DOWNSTREAM FACE)			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
D/S FACE	TYPE	N/A	
	SURFACE CONDITIONS	N/A	
	CONDITIONS OF JOINTS	N/A	
	UNUSUAL MOVEMENT	N/A	
	ABUTMENT CONTACT	N/A	
	LEAKAGE	N/A	
		N/A	
		N/A	
ADDITIONAL COMMENTS:			

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02			
INSPECTION DATE: June 6, 2017		NID ID #: MA00169			
CONCRETE/MASONRY DAMS (UPSTREAM FACE)					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S FACE	TYPE	N/A			
	SURFACE CONDITIONS	N/A			
	CONDITIONS OF JOINTS	N/A			
	UNUSUAL MOVEMENT	N/A			
	ABUTMENT CONTACTS	N/A			
ADDITIONAL COMMENTS:					

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02	
INSPECTION DATE: June 6, 2017		NID ID #: MA00169	
DIKE EMBANKMENT (CREST)			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
CREST	1. SURFACE TYPE	Irregular Vegetation, see note	X
	2. SURFACE CRACKING	None observed	X
	3. SINKHOLES, ANIMAL BURROWS	None observed	X
	4. VERTICAL ALIGNMENT (DEPRESSIONS)	Minor undulations of crest along 1,900-foot length ranging from 142' to 143'	X
	5. HORIZONTAL ALIGNMENT	Good.	X
	6. RUTS AND/OR PUDDLES	None Observed	X
	7. VEGETATION (PRESENCE/CONDITION)	Some small trees (birch, small evergreens) on upstream face near waters edge.	X
	8. ABUTMENT CONTACT	Good	X
ADDITIONAL COMMENTS: Varied including well maintained grass; some previous bare areas being revegetated			

NAME OF DAM: <u>Willett Pond Dam and Dike</u>		STATE ID #: <u>6-11-220-02</u>	
INSPECTION DATE: <u>June 6, 2017</u>		NID ID #: <u>MA00169</u>	
DIKE EMBANKMENT (D/S SLOPE)			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
D/S SLOPE	1. WET AREAS (NO FLOW)	None observed	X
	2. SEEPAGE	None Observed	X
	3. SLIDE, SLOUGH, SCARP	None Observed	X
	4. EMB.-ABUTMENT CONTACT	Good	X
	5. SINKHOLE/ANIMAL BURROWS	None Observed	X
	6. EROSION	None Observed	X
	7. UNUSUAL MOVEMENT	None Observed	X
	8. VEGETATION (PRESENCE/CONDITION)	Irregular grass cover (see comments below)	X
ADDITIONAL COMMENTS: Varied including well maintained grass, areas of recently removed woody vegetation (wood chips), some bare/sandy areas Water collects in swales along the downstream dike toe. These swales outlet toward the road periodically. 			

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02	
INSPECTION DATE: June 6, 2017		NID ID #: MA00169	
DIKE EMBANKMENT (U/S SLOPE)			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
U/S SLOPE	1. SLIDE, SLOUGH, SCARP	None Observed	X
	2. SLOPE PROTECTION TYPE AND COND.	Placed rip-rap along majority of dike	X
	3. SINKHOLE/ANIMAL BURROWS	None Observed	X
	4. EMB.-ABUTMENT CONTACT	Good	X
	5. EROSION	Some areas worn, possibly due to pedestrian traffic	X
	6. UNUSUAL MOVEMENT	None Observed	X
	7. VEGETATION (PRESENCE/CONDITION)	Small trees and bushes along upstream face near water level	X
ADDITIONAL COMMENTS:			

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02	
INSPECTION DATE: June 6, 2017		NID ID #: MA00169	
DIKE INSTRUMENTATION			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
INSTR.	1. PIEZOMETERS	2 piezometers were installed along dike crest. Located near the abutments	X
	2. OBSERVATION WELLS	N/A	
	3. STAFF GAGE AND RECORDER	N/A	
	4. WEIRS	N/A	
	5. INCLINOMETERS	N/A	
	6. SURVEY MONUMENTS	N/A	
	7. DRAINS	N/A	
	8. FREQUENCY OF READINGS	N/A	
	9. LOCATION OF READINGS	N/A	
ADDITIONAL COMMENTS:			

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02	
INSPECTION DATE: June 6, 2017		NID ID #: MA00169	
DIKE DOWNSTREAM AREA			
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION MONITOR REPAIR
D/S AREA	1. ABUTMENT LEAKAGE	None Observed	X
	2. FOUNDATION SEEPAGE	None Observed	X
	3. SLIDE, SLOUGH, SCARP	None Observed	X
	4. WEIRS	None Observed	X
	5. DRAINAGE SYSTEM	None Observed	X
	6. INSTRUMENTATION	None Observed	X
	7. VEGETATION	Ranges from lawn areas to wooded lots	X
	8. ACCESSIBILITY	Accessible from easement at north end of dike; also through select residence yards with permission	X
	9. DOWNSTREAM HAZARD DESCRIPTION	Houses generally set back 100 feet to 300+ feet from dike	
	10. DATE OF LAST EAP UPDATE	3/17/2016	
ADDITIONAL COMMENTS: Generally residential development down stream of the dike.			

NAME OF DAM: Willett Pond Dam and Dike		STATE ID #: 6-11-220-02
INSPECTION DATE: June 6, 2017		NID ID #: MA00169
<div>DIKE MISCELLANEOUS</div>		
AREA INSPECTED	CONDITION	OBSERVATIONS
MISC.	1. RESERVOIR DEPTH (AVG)	Unknown
	2. RESERVOIR SHORELINE	Private residences. Some undeveloped
	3. RESERVOIR SLOPES	Mild to moderate
	4. ACCESS ROADS	Bullard Street in Walpole, Brook street in Norwood
	5. SECURITY DEVICES	NA
	6. VANDALISM OR TRESPASS	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO WHAT: DATE: ACOE Phase 1 - April 1979
	7. AVAILABILITY OF PLANS	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: ACOE Phase 1 - April 1979
	8. AVAILABILITY OF DESIGN CALCS	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: ACOE Phase 1 - April 1979
	9. AVAILABILITY OF EAP/LAST UPDATE	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: 3/1/2016
	10. AVAILABILITY OF O&M MANUAL	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: June 4, 2013
	11. CARETAKER/OWNER AVAILABLE	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: June 6, 2017
	12. CONFINED SPACE ENTRY REQUIRED	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO PURPOSE:
<div>ADDITIONAL COMMENTS: Home owners use the dike for access to Lake. They generally mow grass and in some cases have planted shrubs/flower beds.</div>		



APPENDIX C

Previous Reports and References



PREVIOUS REPORTS AND REFERENCES

The following is a list of reports that were located during the file review, or were referenced in previous reports.

1. Inspection plans for Army Corps of Engineers, prepared by Metcalf & Eddy, Inc., 1979.
2. "Willett Pond Dam, Inspection/Evaluation and Hydraulic/Hydrologic Report," prepared by PARE Engineering, September 2005.
3. "Willett Pond Dam, Phase I Inspection/Evaluation Report," Prepared by GZA GeoEnvironmental, Inc., June 2007.
4. "Operation and Maintenance Plan, Willett Pond Dam and Dike, Dam ID# 6-11-220-02, Army Corp ID# MA0016 Norwood/Walpole, Massachusetts," prepared by NRLHA, Norwood, MA.
5. "Willett pond Dam, 90-Day Follow-up Inspection/Evaluation Report," prepared by Fuss & O'Neill, Inc, January 2008.
6. "Willett Pond Dam, Inspection/Evaluation Report," prepared by Fuss & O'Neill, June 11, 2009.
7. "Willett Pond Dam, Inspection/Evaluation Report," prepared by Fuss & O'Neill, June 22, 2011.
8. "Willett Pond Dam, Phase II Investigation Final Report," prepared by Fuss & O'Neill, Inc., dated July 29, 2011.
9. "Willett Pond Dam, Phase I Inspection/Evaluation Report," prepared by Fuss & O'Neill Inc., dated June 4, 2013.
10. "Willett Pond Dam, Phase I Inspection/Evaluation Report," prepared by Fuss & O'Neill Inc., dated July 7, 2015.

The following references were utilized during the preparation of this report and the development of the recommendations presented herein.

1. "Estimating Peak Discharges of Small, Rural Streams in Massachusetts" (Water Supply Paper 2214), U.S. Geological Survey, Alexandria, VA, 1983.
2. "Recommended Guidelines for Safety Inspection of Dams" (ER 1110-2-106 – National Program of Inspection of Dams, Volume I, Appendix D), U.S. Army Corps of Engineers, Washington, DC, 1976.
3. "Technical Paper No. 40, Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years", US Dept. of Commerce Weather Bureau, Washington, DC, May 1961.



APPENDIX D

Definitions



COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to 302 CMR10.00 Dam Safety, or other reference published by FERC, Dept. of the Interior Bureau of Reclamation, or FEMA. Please note should discrepancies between definitions exist, those definitions included within 302 CMR 10.00 govern for dams located within the Commonwealth of Massachusetts.

Orientation

Upstream – Shall mean the side of the dam that borders the impoundment.

Downstream – Shall mean the high side of the dam, the side opposite the upstream side.

Right – Shall mean the area to the right when looking in the downstream direction.

Left – Shall mean the area to the left when looking in the downstream direction.

Dam Components

Dam – Shall mean any artificial barrier, including appurtenant works, which impounds or diverts water.

Embankment – Shall mean the fill material, usually earth or rock, placed with sloping sides, such that it forms a permanent barrier that impounds water.

Crest – Shall mean the top of the dam, usually provides a road or path across the dam.

Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.

Appurtenant Works – Shall mean structures, either in dams or separate therefrom, including but not be limited to, spillways; reservoirs and their rims; low-level outlet works; and water conduits including tunnels, pipelines, or penstocks, either through the dams or their abutments.

Spillway – Shall mean a structure over or through which water flows are discharged. If the flow is controlled by gates or boards, it is a controlled spillway; if the fixed elevation of the spillway crest controls the level of the impoundment, it is an uncontrolled spillway.

Size Classification

(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 Dam Safety)

Large – structure with a height greater than 40 feet or a storage capacity greater than 1,000 acre-feet.

Intermediate – structure with a height between 15 and 40 feet or a storage capacity of 50 to 1,000 acre-feet.

Small – structure with a height between 6 and 15 feet and a storage capacity of 15 to 50 acre-feet.

Non-Jurisdictional – structure less than 6 feet in height or having a storage capacity of less than 15 acre-feet.



Hazard Classification

(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 Dam Safety)

High Hazard (Class I) – Shall mean dams located where failure will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).

Significant Hazard (Class II) – Shall mean dams located where failure may cause loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s), or cause the interruption of the use or service of relatively important facilities.

Low Hazard (Class III) – Dams located where failure may cause minimal property damage to others. Loss of life is not expected.

General

EAP – Emergency Action Plan – Shall mean a predetermined (and properly documented) plan of action to be taken to reduce the potential for property damage and/or loss of life in an area affected by an impending dam failure.

O&M Manual – Operations and Maintenance Manual; Document identifying routine maintenance and operational procedures under normal and storm conditions.

Normal Pool – Shall mean the elevation of the impoundment during normal operating conditions.

Acre-foot – Shall mean a unit of volumetric measure that would cover one acre to a depth of one foot. It is equal to 43,560 cubic feet. One million U.S. gallons = 3.068 acre feet.

Height of Dam (Structural Height) – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the lowest point on the crest of the dam.

Hydraulic Height – means the height to which water rises behind a dam and the difference between the lowest point in the original streambed at the axis of the dam and the maximum controllable water surface.

Maximum Water Storage Elevation – means the maximum elevation of water surface which can be contained by the dam without overtopping the embankment section.

Spillway Design Flood (SDF) – Shall mean the flood used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works, and for determining maximum temporary storage and height of dam requirements.

Maximum Storage Capacity – The volume of water contained in the impoundment at maximum water storage elevation.

Normal Storage Capacity – The volume of water contained in the impoundment at normal water storage elevation.



Condition Rating

Unsafe – Major structural*, operational, and maintenance deficiencies exist under normal operating conditions.

Poor – Significant structural*, operation and maintenance deficiencies are clearly recognized for normal loading conditions.

Fair – Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters.

Satisfactory – Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result in deficiencies.

Good – No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF.

* Structural deficiencies include but are not limited to the following:

- Excessive uncontrolled seepage (e.g., upwelling of water, evidence of fines movement, flowing water, erosion, etc.)
- Missing riprap with resulting erosion of slope
- Sinkholes, particularly behind retaining walls and above outlet pipes, possibly indicating loss of soil due to piping, rather than animal burrows
- Excessive vegetation and tree growth, particularly if it obscures features of the dam and the dam cannot be fully inspected
- Deterioration of concrete structures (e.g., exposed rebar, tilted walls, large cracks with or without seepage, excessive spalling, etc.)
- Inoperable outlets (gates and valves that have not been operated for many years or are broken)